hand, and that done by our manufacturers, which has, so far, succeeded in keeping them in the van of progress, investigations into the underlying facts of photography may be said to be non-existent in this country. A thousand pounds is a very modest sum to ask for, though no doubt it will serve to make a beginning. We hope that before very long this sum will be multiplied many times over, and that the science of photography will begin to take its proper place, instead of being regarded, as it is too often at present, as a very minor detail of a considerable industry, and an empirical art. The following remarks are from Sir William Abney's address:—

Looking back to the first day of this Society's existence, one is forcibly reminded of the advances that have been made, not only in the science, but in the art of photography, but these advances I think might have been more rapid. A very brief comparison of the processes existing now and fifty years ago will show what I mean. Paper processes, founded on the original process of Fox Talbot, were well to the fore fifty years ago, although in 1851 Scott Archer had shown to the world the practicability of taking photographs on glass by means of collodion. In that same year, when the First International Exhibition was held, calotype, Daguerreotype, and collodion processes were all worked commercially, and photographs of the interior of the Palace by all three processes are in being to-day.

At the present time it may be said that for all practical purposes the gelatine process for taking negatives has complete possession of the field, and ousted all processes which have led up to it. Negatives fifty years ago were impressions only given by the violet and blue rays existing in white light, and the resulting prints are such as would be seen by a person colour blind to the red and the green, whilst now it is not uncommon for the photograph to be made to coincide with visual impression of an ordinary eye.

There seems but little doubt that the photographic image remains of the same nature now as it was then, and whatever may have been the action of light then, so it is now, but the necessary exposure to obtain a properly developable image was at least sixty-fold more than is required for our present process, even when the collodion process was employed, where every condition remained the same except the sensitive surfaces themselves. With the Daguerreotype process perhaps we should have required ten times more than for the collodion, though we know of instantaneous work being done even with that process. For open air portraiture, the early Daguerreotypist required half an hour in bright sunshine, whilst the modern amateur will be content with a second or a fraction of a second in the same circumstances. A question one naturally asks is, What causes the difference? So far as I am aware, this question has not been fully answered, and yet it might have been had serious experiment been undertaken regarding it.

From a theoretical standpoint there are three things that have to be taken into account:—1st, the sensitiveness of the silver salt itself; 2nd, the mediums in which it is placed; and 3rd, the means of development. We have some clue to the last two. Beginning with the last first, those who practised Talbotype or the wet collodion processes know that in both of them the developing solution was an acid solution reduced from nitrate of silver, which was on the surface of the plate or paper, to the metallic state, and that there was some attractive force which caused the metallic silver to adhere to and crystallise on particles of sensitive salt which had been acted upon by light. In the gelatine process we know that development is with alkaline solution, and that the image is built up from the very molecules themselves that have been acted upon, the sensitive salt itself being reduced to metallic silver. Why should development be effected more easily in the one case than in the other? In the case of the acid development the distance of the particles of reduced silver from the molecules altered by light are far greater than they are when the material of the plate is attacked, and consequently a smaller attractive force, due to fewer molecules being altered in the latter case, is efficacious in producing a silver image than in the first case where the depositing silver has a considerable distance into which the attractive force has to be exercised. This might be an explanation. Or, again, it may be shown that a gelatine film, being a kind of filter to the developing solution, acts as a regulator in allowing the active alkaline solution to reach the particles of silver salt, and that this regulated supply would attack the molecules on which light had done part of the work of decomposition, and reached the remaining part most readily to be finished and so on, and that very little external retarding influence was necessary. But now, what is to be said regarding the increased instability of the sensitive salt? This is a question not yet investigated, but it is from such an investigation that increased rapidity is to be looked for.

But it is one thing to say what proof is required, and it is another to have the opportunity of making such proofs, and I should urge that it is part of the duty and functions of the Royal Photographic Society to lead the way in placing such means at the disposal of its members and others as will enable any of them who have the capacity to experiment in this and in any other directions which will lead to a theoretical knowledge of the action of light. It must not be forgotten that there are a great many more men with minds trained to scientific research now than formerly. There are plenty of would-be capable workers who cannot afford a laboratory of their own, and what I should wish to see in this our jubilee year is the commencement of the formation of a research laboratory adapted to the needs of the scientific workers.

One branch of photographic science is the optical, and in it we have an example of what laboratory and experimental research can do when workers are trained in scientific methods. Not many years ago the optician was challenged to increase rapidity of exposure by increased rapidity of lens. Nobly and rapidly he has responded; the advent of Jena glass enabled him to comply with the demand, and we have been getting definition of image with ratio of aperture to focal length which would have been deemed impossible not very many years ago.

I do not believe a laboratory would be an expensive matter to start. What I do advocate is to have all essentials of all instruments of first-class workmanship, and to leave the adaptation of any instrument from one special work to that of another to the worker. Hence, if my views are carried out, the initial expenses will not be so great as might be supposed. Space is the foundation of all research in photography, and that is what the Royal Photographic Society can supply, and then comes the provision of the apparatus necessary to use in such space.

I have heard that one generous man will give 100*l.* to the laboratory if 900*l.* more are raised. The 1000*l.* would go a very long way towards what we want to start with, and I hope the members of the Society will resolve to give substantial help in raising this 900*l.* The jubilee of the Society should be marked by some important piece of work, and no bigger one and more requisite is, to my mind, to be found than starting such a help to the advancement of photography.

## *RADIO-ACTIVE GAS FROM TAP-WATER.*[1]

WHEN Cambridge tap-water is boiled the air given off is mixed with a radio-active gas. The existence of this gas is easily demonstrated by electrical means, for if the air expelled by prolonged boiling from about 10 litres of water is introduced into a closed vessel the volume of which is about 600 c.c., the amount of ionisation in the vessel (as measured by the saturation current) is increased five or six times. When the water has once been well boiled the gas expelled on any subsequent re-boiling is not appreciably radio-active. The gas can also be extracted from water at the temperature of the room by vigorously bubbling air through it; the air as it bubbles through the water gets mixed with the radio-active gas and carries it along with it. When water which has been treated in this way is boiled, no radio-active gas is given out, nor is the gas given off when air is bubbled through water which has been well boiled.

The gas extracted in this way from the water retains its

[1] Paper read before the Cambridge Philosophical Society on May 4 by Prof. Thomson, F.R.S.

radio-active properties after bubbling through strong sulphuric acid, or caustic potash after passing over red-hot copper, or through a narrow platinum tube kept at a white heat; it does not seem appreciably affected when sparks are passed through it.

The gas can diffuse through a porous plate, and by comparing its rate of diffusion with that of $CO_2$ through the same plate, its density can be determined by Graham's law; preliminary measurements of this kind indicate that two different gases are present, of which one has a density about twice, the other between six and seven times that of $CO_2$. The gas obtained by boiling the water always diffused faster than that procured by bubbling air through the water; it seems possible that in the latter case the gas may get loaded with water-vapour to a greater extent than in the former.

A negatively electrified surface exposed to the gas becomes radio-active, the induced radio-activity dying away to half its value in about forty-five minutes. Mr. Adams has shown that a positively electrified surface also becomes radio-active when exposed to the gas, though to a smaller extent than if it had been negatively electrified; an unelectrified surface does not become radio-active. In this respect the gas differs from the emanation from radium, which, according to Rutherford, produces much more induced radio-activity in an unelectrified surface than in a positively electrified one.

The rate of diffusion through a porous plate of the gas obtained by bubbling air through distilled water containing a trace of radium is not the same as that of the gas got by bubbling through tap-water.

If the gas is confined in a closed space its radio-activity slowly diminishes. Mr. Adams found that the gas contained in a vessel of about 300 c.c. capacity lost when not exposed to an electric field about 5 per cent. of its activity in twenty-four hours; under a strong electric field the rate of loss was doubled. Water drawn from the tap and left exposed in a bucket for a fortnight gave off very little of the gas when subsequently boiled. I have not found any of the gas in any of the numerous samples of rain and surface water which I have tested.

Prof. Dewar (to whom I am greatly indebted for assistance and advice) was kind enough to subject the gas obtained by boiling the water to treatment by liquid air. Two samples were treated: one, containing about 80 litres of gas, obtained from the coppers of the Star Brewery, Cambridge, by the kindness of Mr. Armstrong (to whom I wish to express my thanks), was passed slowly through a bath of liquid air, and samples of the emergent gas collected; this on testing was found to have no radio-activity, though it was strongly radio-active before passing through the liquid air; it is evident, therefore, that at the temperature of liquid air the radio-active gas is frozen out. The other sample, of 20 litres, prepared in the laboratory was actually liquefied; the liquid was then allowed to boil away, the gas coming off at the commencement of boiling was collected, and also that coming off when the liquid had all but boiled away. On testing the samples for radio-activity the former was found to be slightly radio-active, but not nearly so much so as before liquefaction, while the second was extraordinarily radio-active, its activity being quite thirty times that of the original gas, thus showing, as we should expect from its great density, that the radio-active gas is much more easily liquefied than air.

The liquid obtained in the preceding experiment had a very strong smell of coal-gas. I must again express my thanks to Prof. Dewar and Mr. Lennox for their kindness in making these experiments.

A discharge tube was filled with strongly radio-active gas obtained as above, and the spectrum was most kindly investigated by Mr. Newall, who photographed it and measured the lines; no new lines were, however, discovered, the lines present being mainly those due to hydrocarbons.

I add a list of the various specimens of water I have examined; yes, means that the water contains the gas; no, that it does not.

Cambridge tap-water (yes). Rain water (no). Water from ditch round Botanical Garden (no). Water from Trinity College well, on the Madingley Road (yes). Water from artesian well in Mr. Whetham's garden, Chaucer Road (yes). Water from shallow well in same garden (no). Water from well at Star Brewery (yes). Artesian well in Trinity Hall Cricket Ground (yes). Artesian well at Girton (yes). Ely Town's water (yes). Birmingham Town's water (yes). Ipswich Town's water (yes).

In concluding this preliminary account I have much pleasure in thanking my assistant, Mr. E. Everett, for his help in this investigation.

## GEOGRAPHICAL RESEARCH.

IN the course of his presidential address at the recent anniversary meeting of the Royal Geographical Society Sir Clements Markham, K.C.B., F.R.S., outlined a scheme, which is shortly to be put in operation by the Society, for the purpose of encouraging geographical research. The plan to be tried is the outcome of the afternoon meetings of the Society, started in 1894, for the reading and discussion of strictly scientific or technical papers. It is hoped that by the plan outlined in the subjoined extract from the president's address, the value of the afternoon meetings will be increased, and the scientific side of geography will be developed.

A permanent committee has been appointed to deal with this department of the work of the Society, to be called the "Research Committee." It will consist of those Fellows, taken from the List of Referees (which includes Fellows who have read papers, published books, or are known to have a special knowledge of any department of geography), who are most interested in, and best qualified to deal with, the subjects which are embraced in geographical research, as distinguished from exploration, in all its numerous branches. The committee will meet for the discussion of such results of investigation as may be brought before it; and the Council may be able to set apart a moderate sum each year for the purpose of encouraging such researches among the younger geographical aspirants.

Among the numerous lines that research may take, the following have been suggested:—

New methods of surveying, mapping, or computing.

Discussion of a definite problem of geomorphology (*e.g.* analysis of a river system or a coast-line).

Discussion of a definite problem of hydrography (*e.g.* circulation of water in a restricted sea area).

Discussion of a definite problem of meteorology (*e.g.* modifications of general weather conditions by local features).

Regional studies (*e.g.* synthesis of the geography of a county or of a natural unit such as the Fens).

Investigation of distribution (*e.g.* of some crop in relation to natural facilities and access to markets; of former forests in relation to existing boundaries; of village and town sites in a district).

Mapping of distribution of plant associations in a given area, or of a human disease in relation to climate and soil.

History of the map of some country (*e.g.* the British Isles).

Investigation of evidence of physical changes within historical times (*e.g.* the British coasts; the desiccation of continents).

Discussion of the relation of land forms to military movements in a selected area, or a chosen campaign.

Discussion of the relation of land forms to the distribution of man; to the distribution of animals in any area.

Geographical conditions affecting the development and colonisation of any given region.

Complete investigations from the geographical standpoint of a limited area of unexplored or partially explored territory.

There is still ample room for exploration and expeditions of discovery. We have scarcely yet laid down the great lines of the world's geography, and there is work for generations to come in filling in the details, though future exploration must become more and more exact and scientific in its characters. But we ought also to encourage research, for which exploration furnishes the raw material. By the plan now in contemplation, we shall develop the purposes of the List of Referees by constituting the Research Committee; and we shall develop further the object of the afternoon meetings by promoting research, the results of which will place the meetings on a more assured and regular system, by creating the necessity for their being more frequent and at fixed intervals.